



Minimum Requirements for the Self-Monitoring of Effluent Flow

Environment Agency
Version 3.4
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Foreword

We set up our Monitoring Certification Scheme (MCERTS) to provide a framework of standards you can use to monitor things that affect the environment. MCERTS covers:

- the standards of performance that your monitoring equipment must meet
- the level your staff must be qualified to
- accrediting laboratories and on-site inspections in line with European and international standards.

The standard we focus on in this document sets out what you must do if you monitor your organisation's flow of liquid waste. The standard may apply to you if you have a permit under the Environmental Permitting Regulations, which says you must:

- monitor the flow of sewage or trade waste to waters we regulate, for example rivers
- collect and bring together that information.

If your permit says that you must monitor the flow of liquid waste, you must have your arrangements to monitor flow independently assessed against this standard. An MCERTS Inspector must carry out this assessment. The Inspector must have met the conditions of the 'Competency standard for MCERTS Inspectors and Assistant Inspectors – effluent flow monitoring'. Sira Certification Service runs this scheme on our behalf.

Under MCERTS, the arrangements you use to monitor the flow of liquid waste must measure the total volume of liquid waste released each day. Your measurements must be no more than $\pm 8\%$ lower or higher than the actual value.

The benefits of this standard

- The standard makes sure that you, the public and other organisations involved in measuring the flow of liquid waste can be confident that the information you provide is reliable.
- Everybody in the competitive market of measuring the flow of liquid waste will be working towards meeting the same standard.
- The standard sends a message that measuring the flow of liquid waste is an important part of producing reliable information for regulatory purposes.
- By setting quality standards which everybody must work towards, the standard promotes and raises the professional reputation of staff and organisations involved in measuring the flow of liquid waste.

If you meet the standard, Sira will issue you with a certificate on our behalf.

If you have any questions about the inspection, please contact:

Sira Certification Service

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You can get more information on MCERTS, including the standards related to monitoring flow, from our website at www.mcerts.net

If you have any general questions about MCERTS, please contact:

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Minimum Requirements for the Self-Monitoring of Effluent Flow

Contents

1.	Introduction	1
2.	Outline of the scheme	2
2.1	Operation of the scheme	2
2.2	The MCERTS inspection process	2
2.3	Failed site requirements	3
2.4	Failed management system requirements	3
2.5	Dispensations	3
3.	Flow-monitoring installations	4
3.1	Flow monitoring	4
3.2	Site performance requirements	5
3.3	The role of MCERTS Inspectors & Assistant Inspectors	5
3.4	Conformance assessment	5
4.	Quality assurance	6
4.1	Introduction	6
4.2	Management system	7
4.3	Simplified management system	7
4.4	Quality and/or environmental policy	8
4.5	Management responsibilities	8
4.6	Quality manual and/or environmental documentation	8
4.7	Operating procedures	9
4.8	Document control	9
4.9	Equipment inventory	9
4.10	Maintenance	9
4.11	Commissioning	9
4.12	Site Changes	9
4.13	Verification	10
4.14	Data treatment	10
4.15	Preventative and corrective actions	10
4.16	Internal audits	10
4.17	Conformance assessment – management system	10
4.18	Conformance assessment – simplified management system	11
5.	Re-certification	11
6.	Status of this document	11
	Appendix 1 - Guideline to estimate the uncertainty in Total Daily Volume	12
	Appendix 2 - Open channel flow measurement system concessions	17
	Appendix 3 - Electromagnetic flowmeters for liquid flow in pipes	21

Record of amendments

There have been a significant number of updates throughout the standard. This record of amendments only identifies the most major changes.

Version number	Date	Amendment
3.3	Sept 10	Throughout document – update to reflect the introduction of the Environmental Permitting Regulations (EPR)
3.3	Sept 10	Throughout document – update of Sira web site details
3.3	Sept 10	Section 2 “Outline of the scheme” - written to make clear the requirement for the management system audit and the role of the management system auditor.
3.3	Sept 10	Section 2.2 – confirmation that maintenance must be seen to being carried out before a conformance certificate can be issued
3.3	Sept 10	Section 3.1 “Flow monitoring” – requirement for MCERTS product certification confirmed.
3.3	Sept 10	Section 3.2 “Site performance requirements” – maintenance of product certification.
3.3	Sept 10	Section 3.4 “Conformance assessment” – closed pipe meters changed to electromagnetic flowmeters.
3.3	Sept 10	Section 4 “Quality assurance” – written to reflect Agency policy for EPR installations
3.3	Sept 10	Reference page deleted
3.3	Sept 10	Appendix 2: Section 2.4 – confirmation that an installation can still meet the target uncertainty of better than ± 8 % even if the concessions are exceeded – provided that the MCERTS Inspector can justify it.
3.3	Sept 10	Appendix 3: “Electromagnetic flowmeters for liquid flow in pipes”. Guidance notes now mandatory requirements throughout.
3.3	Sept 10	Appendix 3: “Meter performance” – requirement for new or replacement electromagnetic flowmeter installations to be provided with a means of access to allow inspections of the sensor to take place.
3.3	Sept 10	Appendix 4: “Examples of installation, re-validation and maintenance considerations”. Deleted
3.4	March 2012	Whole document: References to BS3680 replaced with appropriate ISO Standards references
3.4	March 2012	Section 2.5.6: New section - clarification of the requirement for the management system audit if dispensation granted.
3.4	March 2012	Section 3.1.2: Text clarified regarding requirement to use flowmeters certified under MCERTS for new and replacement installations.
3.4	March 2012	Section 3.4.1: Text moved to (new) 3.4.3
3.4	March 2012	Section 3.4.6: Terminology revised to commonly used term “calibration reference plate”
3.4	March 2012	Section 3.4.7: New requirement for MCERTS inspector to check local display
3.4	March 2012	Section 3.4: Clause numbering revised to take account of new paragraphs
3.4	March 2012	Section 5.2: clarification for the need to re-assess the management system
3.4	March 2012	Appendix 2 Section A2.7 Text on baffles moved to new paragraph A2.8
3.4	March 2012	Appendix 2 Section A2.8 New paragraph regarding use of baffles and flow straighteners
3.4	March 2012	Appendix 2: Secondary device table. Requirement for sensor position on weirs updated to reflect current ISO Standard and note added regarding systems designed under previous BS Standard
3.4	March 2012	Appendix 3: Clarification throughout.

Minimum Requirements for the Self-Monitoring of Effluent Flow

1 Introduction

- 1.1 The effective environmental protection and management of water bodies receiving effluent discharges requires knowledge about the mass release rate of pollutants. This is achieved by combining flow-measurement data (volume/time) with pollutant concentration (mass/volume). This MCERTS standard specifies the Environment Agency's minimum requirements for the self-monitoring of effluent flow. This standard covers:
- performance requirements for flow-metering installations in terms of a target measurement uncertainty;
 - quality assurance system requirements to ensure the ongoing performance of flow metering installations.
- 1.2 Conformance with this MCERTS standard is based on assessment of the flow-monitoring arrangements by MCERTS Inspectors and assessment of the supporting management system by MCERTS management system auditors. MCERTS Site Conformity Inspection Certificates are issued to Operators (Permit Holders regulated under the Environmental Permitting Regulations - EPR) following satisfactory assessment against this standard.
- 1.3 This standard currently applies to:
- Sites with permits issued under the Environmental Permitting Regulations (EPR) including:
 - industrial sites previously regulated under the Pollution Prevention and Control Regulations
 - Water Utility sewage treatment works previously regulated under the Water Resources Act
 - other sites with permits transferred to EPR if the flow monitoring arrangements are significantly changed
 - new installations with permits issued under EPR
 - Sites falling under the Urban Wastewater Treatment Directive (UWWTD) (91/271/EEC and 98/15/EEC).
 - Sites with permits issued under the Radioactive Substance Regulations.
- 1.4 This standard has prescriptive elements primarily based on recognised BS, EN and ISO Standards, supported by the professional judgement of MCERTS Inspectors during their inspection of the flow-monitoring arrangements.

2 Outline of the scheme

2.1 Operation of the scheme

- 2.1.1 Sira operates the scheme on behalf of the Environment Agency. Sira also provides bulletins (additional detailed procedures and guidance) which are available at www.siraenvironmental.com/mcerts.
- 2.1.2 MCERTS Inspectors are assessed and appointed by Sira in accordance with the MCERTS Standard: *Competency Standard for MCERTS Inspectors & Assistant Inspectors – effluent flow monitoring*. Contact details for MCERTS Inspectors are available at www.siraenvironmental.com/mcerts.
- 2.1.3 MCERTS Inspectors assess effluent flow monitoring arrangements in accordance with this MCERTS Standard: *Minimum Requirements for the Self-monitoring of Effluent Flow*.
- 2.1.4 MCERTS management system auditors conduct an assessment of the management system relating to the Operators effluent flow monitoring arrangements in accordance with this MCERTS Standard: *Minimum Requirements for the Self-monitoring of Effluent Flow*.

2.2 The MCERTS inspection process

Step 1

The Operator chooses an MCERTS Inspector from the list of Service Providers maintained on the Sira web site.

The MCERTS Inspector undertakes an inspection of the site process configuration/flow monitoring arrangements and prepares an Inspection Report. The MCERTS Inspector provides the Operator with a copy of the Inspection Report.

The MCERTS Inspector shall use on-site and other evidence to ensure that the flow monitoring installation is being satisfactorily maintained. Installations with, for example, restricted access shall have specific maintenance procedures detailing how maintenance can be carried out. An MCERTS Site Conformity Inspection Certificate cannot be issued unless there is evidence that the installation is being maintained.

The MCERTS management system auditor conducts an assessment of the management system requirements relating to effluent flow monitoring and produces an audit report.

Step 2

Provided that the MCERTS requirements are met, the Operator makes an application to Sira for an MCERTS Site Conformity Inspection Certificate. The MCERTS Inspector may make the application on behalf of the Operator.

The application must include the MCERTS Inspection Report, the MCERTS management system audit report and the appropriate fee.

Step 3

Sira reviews the evidence included in the application. Provided that the MCERTS requirements are met, Sira issues an MCERTS Site Conformity Inspection Certificate to the Operator. Inspection Certificates are valid for five years.

In order to maintain certification throughout the certification period, the Operator's management system shall be subjected to periodic surveillance. The first surveillance visit will be conducted approximately 12 months after the initial assessment. Thereafter, the frequency of surveillance will be agreed with the Operator, based on the audit findings. Re-assessment of the management system is conducted every five years.

2.3 Failed site requirements

2.3.1 If a site fails to meet the MCERTS site requirements, remedial work shall be carried out. The MCERTS Inspector shall provide guidance on the remedial work required to bring the site into conformity with MCERTS requirements.

2.3.2 On completion of the remedial work, the MCERTS Inspector conducts a re-inspection to confirm that the site is now in conformity with MCERTS requirements.

2.3.3 Provided that the MCERTS requirements are met, the MCERTS Inspector provides the Operator with an MCERTS Inspection report confirming that the site now meets the MCERTS requirements.

2.3.4 The Operator can then apply to Sira for an MCERTS Site Conformity Inspection Certificate.

2.4 Failed management system requirements

2.4.1 Where significant deficiencies are identified in the Operator's management system, these will be recorded and presented to the Operator during audit. The Operator will be given an opportunity to address the deficiencies and provide evidence of corrective action. Further audits may be required to collect evidence that the deficiencies have been resolved.

2.4.2 Provided that the MCERTS management system requirements are met, the auditor provides the Operator with a report confirming that it now meets the MCERTS requirements.

2.4.3 The Operator is then able to apply for an MCERTS Site Conformity Inspection Certificate from Sira.

2.5 Dispensations

2.5.1 A site may fail to comply with MCERTS requirements in a relatively minor way but the cost of immediate rectification is high. In these exceptional cases an application can be made to the Environment Agency for a dispensation. This will require a cost/benefit business case to be produced. A copy of the (non-compliant) MCERTS Inspection report shall be included with the application for a dispensation. The report shall confirm why the site does not meet the MCERTS requirements, the likely effect of the deficiency on the total daily flow records and include details of the suggested remedial work required to remedy the situation.

- 2.5.2 Provided that the Environment Agency agrees with the submission the Operator will be issued with a dispensation for the site in question. The dispensation will include a reference to the (non-compliant) MCERTS Inspection report. The Environment Agency may also wish to discuss the matter with the MCERTS Inspector to clarify any points prior to making a decision.
- 2.5.3 The Operator then makes an application to Sira which shall include the (non-compliant) MCERTS Inspection report, a copy of the dispensation issued by the Environment Agency, evidence that the MCERTS management system requirements have been met and the fee.
- 2.5.4 On receipt of the application, Sira will review the evidence submitted and issue an MCERTS Site Conformity Inspection Certificate. The Inspection Certificate will contain a reference to the dispensation.
- 2.5.5 Dispensations are not a permanent provision and it is expected that Operators will need to resolve the problem as soon as reasonably practicable. If a dispensation needs to be extended at the first re-certification then the Operator needs to re-justify the need, including an explanation as to why it has not been resolved in the preceding five years. Normally, only one extension of a dispensation will be allowed.
- 2.5.6 Where a dispensation is granted, the operator is still required to maintain a management system (section 4.2). The management system shall be subject to periodic surveillance.

3 Flow monitoring installations

3.1 Flow monitoring

- 3.1.1 The Environment Agency may include conditions in a permit requiring the Operator to measure the volume and flow of liquid effluent discharges.
- 3.1.2 The Environment Agency allows Operators to select the flow measurement system that they believe is best suited to their discharge. However, from April 2010 any new or replacement flowmeters¹ shall maintain product certification under the MCERTS standard: *Performance Standards and Test Procedures for Continuous Water Monitoring Equipment - Part 3*. This standard is available at www.mcerts.net. An exception can only be made if there is no suitable MCERTS certified product available for the specific installation and it is agreed in writing by the Environment Agency.
- 3.1.3 The Environment Agency will require the Operator to record flow data and make returns as specified in their permit or the Environment Agency's Flow Policy. Flow measurement may be carried out at any appropriate location in the effluent treatment process, as long as it is representative of the total daily volume discharged.

¹ For the purposes of this standard, a flowmeter is an instrument which measures the flow-rate or totalised volume of fluid passing along a pipe or channel, or computes such quantities from measurements of one or more properties which have a defined relationship with the flow-rate.

3.2 Site performance requirements

- 3.2.1 The total daily volume of the discharge as specified in the permit shall be measured with a target uncertainty of better than $\pm 8\%$ at a confidence level of 95%, calculated as detailed in Appendix 1.
- 3.2.2 The location of the flow-monitoring installation shall ensure representative measurement of the total volume discharged.
- 3.2.3 The MCERTS Inspector shall establish that the primary and secondary installation, their installation and ongoing operation (for example, flume/weir plus level measuring devices) are fit for purpose. If flowmeters maintain product certification under the MCERTS standard: *Performance Standards and Test Procedures for Continuous Water Monitoring Equipment - Part 3*, they shall be regarded as fit for purpose. Nevertheless, the requirements of this MCERTS standard shall apply to their installation and on-going operation.

3.3 The role of MCERTS Inspectors and Assistant Inspectors

- 3.3.1 An MCERTS Inspector is a technical specialist who can demonstrate considerable experience and expertise in assessment of flow monitoring arrangements. A key role of the MCERTS Inspector is to exercise professional judgement. An MCERTS Inspector is able to assess potential effects of deviations in flow monitoring arrangements and estimate these as part of an uncertainty calculation. An MCERTS Inspector can work in isolation or may supervise the work of others.
- 3.3.2 The competency requirements for MCERTS Inspectors and Assistant Inspectors and the duties that they may perform are specified in *Competency Standard for MCERTS Inspectors and Assistant Inspectors – effluent flow monitoring (section 3)*. This can be found at: www.mcerts.net.
- 3.3.3 An Assistant Inspector has specific technical expertise, primarily in obtaining dimensional measurements of effluent flow monitoring structures and/or site process configuration. They will have the necessary competence to undertake these measurements unsupervised. Data and information recorded by an Assistant Inspector must be quality checked and controlled by an MCERTS Inspector. Any subsequent professional judgement must be applied by the MCERTS Inspector.
- 3.3.4 It is not acceptable for an MCERTS Inspector to simply conduct a desk review of an inspection carried out by an Assistant Inspector. The MCERTS Inspector must visit the site.
- 3.3.5 Individuals, for example MCERTS trainees, not appointed as MCERTS Inspectors or Assistant Inspectors, must be accompanied and supervised by an MCERTS Inspector.

3.4 Conformance assessment

- 3.4.1 The total daily volume shall be measured with an uncertainty of better than $\pm 8\%$.
- 3.4.2 The MCERTS Inspector shall assess conformance by using recognised Standards and by using their professional judgement. Appendix 2 provides guidance on “concessions” from International Standards for open channel flow structures. Appendix 3 provides guidance on the uncertainties that can be found on installations using electromagnetic flowmeters. The MCERTS Inspector shall provide written

justification if, in his/her opinion, the $\pm 8\%$ target uncertainty will still be achieved despite concessions outlined in Appendix 2 being exceeded.

- 3.4.3 The MCERTS Inspector shall assess the suitability of the flow monitoring installation for the discharge being assessed by site inspection and examination of flow diagrams. The MCERTS Inspector shall ensure that any flow diagrams provided are representative and accurate. The site inspection shall include a full walking audit of the site to establish the process routes for all relevant inflows, overflows, re-circulation and process returns.
- 3.4.4 The MCERTS Inspector shall assess the location of the measurement structure and the impact of hydraulic influences both upstream and downstream to cover the full range of flow conditions.
- 3.4.5 The MCERTS Inspector shall confirm the adequacy of site maintenance arrangements. Any evidence of inadequate maintenance shall be recorded in the Inspection report for subsequent investigation during the management system assessment. An MCERTS Site Conformity Inspection Certificate cannot be issued unless there is evidence that the installation is being maintained
- 3.4.6 The MCERTS Inspector shall carry out calibration/set up checks on the measuring instruments. These checks shall record the set up programme of the measurement instrument to include the zero set up, calibration reference plate setting, calculation method, programmed dimensions, range etc.
- 3.4.7 The MCERTS Inspector shall confirm that any local display is in agreement with the flowmeter output.
- 3.4.8 The MCERTS Inspector shall record conformance with the requirements of this standard. The information gathered during the inspection shall be used to assess the suitability and uncertainty of the flow measurement installation, which is to be included in the inspection report and forwarded to Sira.
- 3.4.9 Any methods of effluent flow measurement can be used provided the target uncertainty of $\pm 8\%$ (or better) at a confidence level of 95% is achieved. In order to ensure a consistent approach, the MCERTS Inspector shall liaise with Sira regarding certification of "unusual" installations.
- 3.4.10 A calibrated transfer standard flowmeter provided with a certificate of calibration under ISO17025 or equivalent may be used as a method for assessing the suitability of the effluent flow monitoring installation. The MCERTS Inspector shall ensure that all provisions of this standard are complied with.
- 3.4.11 Sira will only issue an MCERTS Site Conformity Certificate if all relevant requirements of the MCERTS standard have been met. The MCERTS Site Conformity Certificate shall be dated to coincide with the date of inspection of the effluent flow monitoring arrangements.

4 Quality assurance

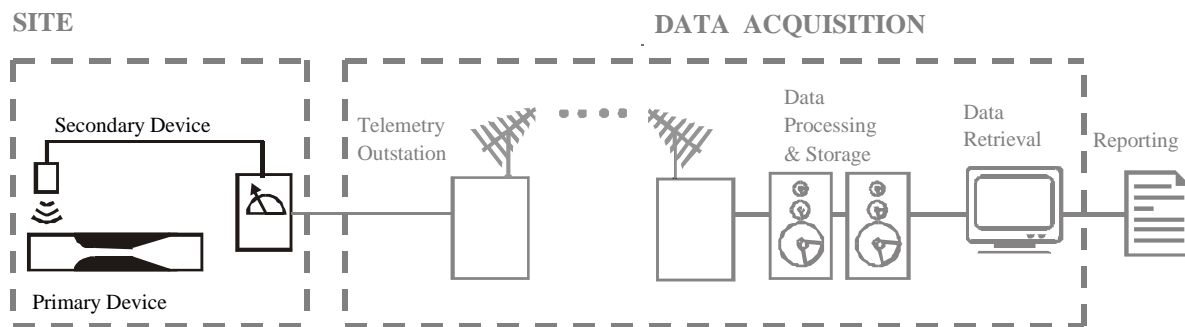
4.1 Introduction

- 4.1.1 The Operator shall establish and maintain a management system (quality management system and/or environmental management system) for its effluent flow monitoring arrangements, to ensure that the performance requirements specified in

Section 3.2 are met at all times. Detailed guidance covering each of the management system requirements is available from Sira at www.siraenvironmental.com/mcerts

4.1.2 Figure 1 shows a typical schematic of a typical open channel flow measurement system whereby data are sent remotely to a centralised location. It indicates the division of responsibility for assessment of the two key areas i.e. site process configuration/flow measurement system and the management system. The site process configuration, primary device and secondary device are the subject of a site assessment. Data acquisition and telemetry are assessed by auditing the Operator's management system.

Figure 1 – Schematic of a flow measurement system



4.2 Management System

4.2.1 A management system is a requirement for EPR and RAS regulated sites. The management system shall include statements, information and/or documented procedures, as appropriate, covering:

- quality and/or environmental policy – section 4.4
- management responsibilities – section 4.5
- quality manual or environmental documentation – section 4.6
- operating procedures – section 4.7
- document control – section 4.8
- equipment inventory – section 4.9
- maintenance – section 4.10
- commissioning – section 4.11
- site changes – section 4.12
- verification – section 4.13
- data treatment – section 4.14
- preventative and corrective actions – section 4.15
- internal audit section – 4.16.

4.3 Simplified Management System

4.3.1 In the future as MCERTS is extended, some sites, such as private sewage treatment works, that are now regulated under EPR may (at the discretion of the Environment Agency) be given the option to have a simplified management system assessed by the MCERTS Inspector as part of their site inspection. An audit of a simplified management system will focus on the following requirements:

- management responsibilities – section 4.5
- equipment inventory – section 4.9

- maintenance – section 4.10
- site changes – section 4.12
- verification – section 4.13
- data treatment – section 4.14

4.3.2 MCERTS Inspectors shall demonstrate to Sira their competence to carry out simplified management system audits. Sira will provide guidance on the audit structure.

4.4 Quality and/or environmental policy

4.4.1 The Operator shall have a written quality and/or environmental policy. This will typically include the following, or equivalent, statements:

- the policy of (organisation name) is to achieve and maintain a consistent and adequately high standard in its approach to all legal compliance;
- it is the responsibility of all the organisation's staff involved in flow monitoring to familiarise themselves with the quality policy;
- the above quality and/or environmental policy statement is made on the authority of (named director).

Responsibility for implementation of the policy and for control of quality shall be defined.

4.5 Management responsibilities

4.5.1 The Operator shall ensure that responsibilities and authorities are defined and communicated to all relevant personnel. Designated personnel, irrespective of other responsibilities, shall have responsibility and authority for:

- ensuring that management system procedures are established, implemented and maintained;
- reporting to senior management, and liaising with Sira and the Environment Agency on the performance of the flow-monitoring arrangements, including the management system and the need for any improvements;
- ensuring the requirements of the management system in relation to meeting the performance targets are understood and appropriate training has been received by all relevant personnel.

4.5.2 The Operator shall make available organisational charts showing the company structure and flow monitoring responsibilities. Job descriptions of staff involved in flow self-monitoring shall be available on request, but not necessarily held on site. They shall include job title, description of duties, qualifications, training and experience requirements, responsibilities and limits.

4.6 Quality manual and/or environmental documentation

4.6.1 The management system shall be defined in a quality manual and/or environmental documentation. This shall identify the structure of the organisation and describe its range of flow monitoring operations.

4.6.2 All of the Operator's personnel are required to adhere to the policies and procedures documented in the quality manual and/or environmental documentation.

4.7 Operating procedures

- 4.7.1 All operating procedures shall be documented. Procedures and amendments shall be issued on the authority of a competent person responsible for the flow monitoring arrangements.

4.8 Document control

- 4.8.1 Authorising and maintaining controlled documentation, including the quality manual and operating procedures, shall be the responsibility of designated competent personnel.
- 4.8.2 Controlled documentation shall not be amended without the authorisation of designated competent personnel or their appointed deputies.

4.9 Equipment inventory

- 4.9.1 A list of major items of equipment and the location of each shall be maintained (a major item is defined as equipment that is critical to the validity of effluent flow monitoring for example, the sensor and electronics).
- 4.9.2 Equipment records shall be kept for every major item. The records shall contain details of the equipment, a unique identifying code and any relevant calibration and maintenance requirements.

4.10 Maintenance

- 4.10.1 Appropriate maintenance of the flow monitoring arrangements shall be carried out. Equipment shall be maintained/serviced at pre-defined intervals (for example, according to manufacturers' instructions or operating procedures) and whenever a significant deterioration is noticed. The frequency of scheduled maintenance activities, such as removal of fouling, shall be supported by documented observations. Up to date maintenance records shall be completed in a timely manner and kept where they can be accessed. These records shall include any problems encountered, for example due to adverse weather conditions.

4.11 Commissioning

- 4.11.1 The Operator shall have a procedure for commissioning new or modified flow monitoring systems to check their conformity with the requirements in Section 3.2.

4.12 Site changes

- 4.12.1 The Operator shall establish and maintain a procedure to ensure that any significant changes are documented and the risk of any changes influencing the performance of the flow-monitoring equipment is assessed by a competent person and any corrective actions identified. Any changes that may impact on the flow measurement shall be agreed with the Environment Agency.
- 4.12.2 The Operator shall establish and maintain a procedure to ensure a competent person assesses the effect of any changes to the flow monitoring installation, for example, replacement of any instrumentation. The competent person can then decide whether inspection by an MCERTS Inspector is necessary. If the Operator decides that the change does not invalidate the MCERTS Site Conformity Inspection Certificate, and re-certification is not necessary, the Operator shall document their

justification and assessment. The justification must be available to, and may be reviewed by, an MCERTS Inspector at the next inspection visit.

- 4.12.3 If the Operator's assessment indicates that the MCERTS Site Conformity Inspection Certificate has been invalidated then inspection by an MCERTS Inspector is required as soon as practicable.

4.13 Verification

- 4.13.1 The Operator shall undertake appropriate verification procedures between MCERTS inspections over the entire certification period, to ensure that the flow-monitoring equipment is operating satisfactorily.

4.14 Data treatment

- 4.14.1 Where applicable, procedures for data treatment shall be included in the management system. The Operator's management system shall define the maximum acceptable data treatment/telemetry error.

- 4.14.2 The management system assessor is not required to carry out data treatment/telemetry verification measurements, but is required to ensure that:

- the appropriate checks are specified in the Operator's operating procedures
- the procedures are being implemented in a timely and appropriate manner
- the results are being recorded and analysed
- and that these are included in the overall assessment of the total daily uncertainty.

4.15 Preventative and corrective actions

- 4.15.1 In the event of departures from the quality manual or operational procedures, corrective actions shall be instigated. Corrective actions are the responsibility of the designated competent person. Having identified the cause, potential corrective actions shall be identified and corrective actions proportionate to the problem taken to correct matters and avoid a recurrence. Preventative action would include, for example, a periodic review of trend plot analysis of flow data. Preventative and corrective actions shall be documented to demonstrate continuous improvement.

4.16 Internal audits

- 4.16.1 Internal audits shall be performed according to a defined schedule to verify that operations continue to comply with the requirements of the management system. It is the responsibility of the designated competent person to plan and organise such audits. They shall be carried out by trained personnel who are operationally independent of the activity to be audited. Personnel shall not audit their own activities, except when it can be demonstrated that it will be effective.

- 4.16.2 The audit findings and any corrective actions arising from them shall be recorded. The Operator shall ensure that corrective action is implemented within an agreed time.

4.17 Conformance assessment – management system

- 4.17.1 The Certification Body conducting the management system audit shall be a UKAS accredited Certification Body or a Certification Body that is accredited by an

Accreditation Body that is an International Accreditation Forum Multilateral Recognition Agreement signatory. Certification Bodies should have MCERTS: Self monitoring of effluent flow included in their scope of accreditation. The management system assessor shall work on behalf of an accredited Certification Body.

- 4.17.2 The management system auditor shall assess the Operator's management system to ensure that the requirements of sections 4.4 to 4.16 have been met in relation to the effluent flow monitoring arrangements.

4.18 Conformance assessment – simplified management system

- 4.18.1 The MCERTS Inspector shall demonstrate to Sira their competence to carry out simplified management system audits. Sira will provide guidance on the audit structure. A copy of this guidance shall be made available by Sira.

- 4.18.2 The MCERTS Inspector shall assess the Operator's simplified management system to ensure that the requirements of the relevant sections have been met in relation to the effluent flow monitoring arrangements.

5 Re-certification

- 5.1 An MCERTS Site Conformity Inspection Certificate is valid for five years. Sites shall undergo re-certification within a period of five years from the previous MCERTS certification.

- 5.2 Sites can be re-inspected up to 12 months in advance of the Site Conformity Inspection Certificate renewal date. If the site passes the re-inspection, then a new Certificate can be issued to run for five years from the expiry of the old Certificate. If the site fails the re-inspection, remedial work shall be carried out as soon as is practicable. A further inspection by the MCERTS Inspector is required to confirm that the site now meets the MCERTS requirements. The site shall meet the MCERTS requirements before the expiry of the current certificate which includes a re-assessment of the management system.

- 5.3 If there are any changes to the flow-monitoring arrangements that may affect the $\pm 8\%$ uncertainty, then re-certification shall be required as soon as is practicable.

6 Status of this document

- 6.1 This MCERTS standard may be subject to review and amendment following publication. The latest version is available on the Environment Agency website at:

www.mcerts.net

- 6.2 Sira will issue bulletins that provide updates on additional guidance and/or instructions. These are available at: www.siraenvironmental.com/mcerts.

- 6.3 If you have any questions regarding the inspection process, please contact Sira at:

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Appendix 1

Guideline to estimate the uncertainty in total daily volume

Introduction

A1.1 Any measurement result is complete only when accompanied by a quantitative statement of its uncertainty. The uncertainty is required in order to decide if the result is adequate for its intended purpose. As any measurement is subject to imperfections, uncertainty is an unavoidable part of that measurement and is a consequence of random and systematic effects. The level of uncertainty can be quantified, for example, by estimation based on data from records, previous (and/or comparative) measurements, knowledge of the equipment and its installation.

Background

A1.2 The uncertainty in flow measurement is normally inversely related to the discharge: the lower the flow the higher the uncertainty and vice-versa. This is a feature of all methods of determining discharge but is particularly pronounced where open channel flow measurement systems are used.

A1.3 MCERTS requires that the total daily volume must be measured with a target uncertainty of $\pm 8\%$ or better. This appendix provides a generic method for computing the estimated uncertainty in total daily volume.

Inputs

A1.4 The methodology requires two inputs: (i) the unique flow-v-uncertainty curve² for the flow measurement system being certified and (ii) a set of flow data which is representative of a "dry" day³. These are compared to determine both total daily volume and an estimation of its uncertainty⁴. Figure 1 Appendix 1 represents this process.

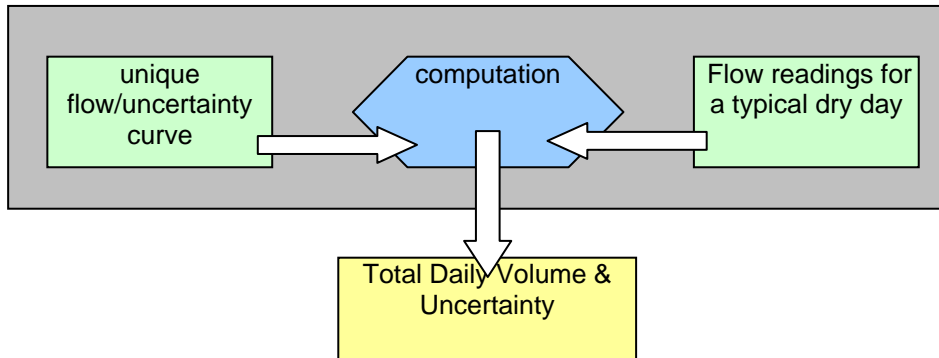
² Provided by the MCERTS Inspector.

³ Normally compiled from a series of 96 fifteen minute values in a typical dry day. Each 15 minute value is taken as the average flow in that period. Real values are provided by the operator but may be substituted using generic algorithms or curves by either the operator or MCERTS Inspector where this information is unavailable.

⁴ This could be achieved on-site, separately or by (emerging) instrumentation that has this capability.

Figure 1 Appendix 1

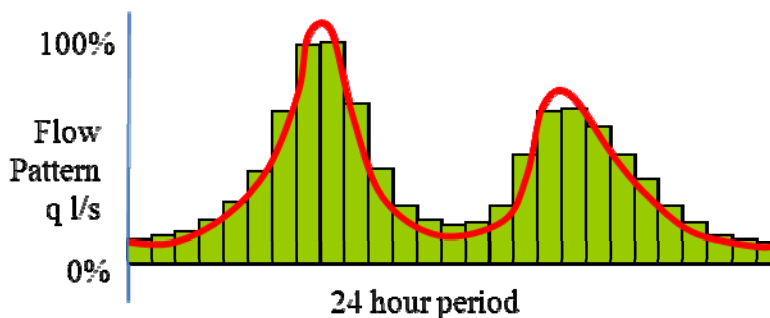
Model for computing total daily volume and its uncertainty



Computation of total daily volume and its uncertainty

A1.5 Total daily volume is traditionally calculated by adding the instantaneous flow values for the day. Figure 2 Appendix 1 shows a typical diurnal flow pattern for a sewage treatment facility. The red line represents the instantaneous flow readings; the area under the red line represents the true total daily volume.

Figure 2 Appendix 1: Diurnal flow pattern



A1.6 A common method of recording flow values is to store the instantaneous flow readings averaged over a 15 minute period; this is represented by the green bars. In a day 96 x 15 minute average flow readings, q_n , will be obtained for each flowmeter. An accurate calculation of total daily volume is established by adding these values together (assuming that there is only one flowmeter). Total daily volume is, therefore, calculated as follows:

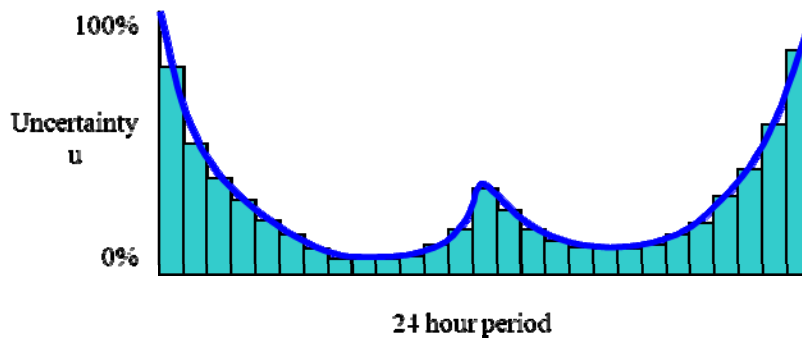
$$\text{Total Daily Volume (m}^3\text{)} \quad Q = \sum \left(\frac{q_n \times 15 \times 60}{1000} \right)$$

where

- Q = Total Daily Volume (m³)
- q_n = is the 15 minute average flow reading (l/s)
- n = value number (normally 1 to 96 for 15 minute readings)

A1.7 Clearly there is a corresponding uncertainty pattern that is related to the flow measurement system under observation, see Figure 3 Appendix 1. The blue line illustrates this.

Figure 3 Appendix 1: Uncertainty pattern (related to flow)



A1.8 The uncertainty in the total daily volume is not simply the average of the uncertainties over the 24 hour period. The uncertainty in total daily volume is the volume weighted average of the individual uncertainties. This is because high uncertainties tend to be associated with low flows and vice versa. Simply averaging the uncertainties can lead to a value far greater than the target $\pm 8\%$ required under MCERTS. This is particularly evident when a diurnal pattern has long periods of low flow.

A1.9 The flow weighted uncertainty in total daily volume is derived using the following formula:

$$\text{Uncertainty in Total Daily Volume (\%)} \quad U_Q = \sum \frac{(q_n \times 15 \times 60) \times u_n}{Q \times 1000}$$

where

U_Q = the uncertainty in the Total Daily Volume (%)

Q = Total Daily Volume (m^3)

q_n = the 15 minute average flow reading in (l/s)

u_n = the uncertainty related to the 15 minute average flow reading (%) -derived from the unique flow-v-uncertainty relationship)

n = value number (normally 1 to 96 for 15 minute readings in a day)

Worked example

A1.10 A small triangular v-notch weir forms part of the flow measurement system; this is the only flowmeter used to determine discharged flow on the site. The unique flow-v-uncertainty curve one might expect to receive is presented in Table 1 Appendix 1, as follows:

Table 1 Appendix 1: Typical Flow/Uncertainty Relationship

No	Head (mm)	Flow (l/s)	Uncertainty* (± %)	No	Head (mm)	Flow (l/s)	Uncertainty* (± %)
1	7.5	0.001	25.7	11	82.5	0.579	2.6
2	15.0	0.008	12.8	12	90.0	0.715	2.5
3	22.5	0.023	8.6	13	97.5	0.869	2.3
4	30.0	0.047	6.55	14	105.0	1.041	2.2
5	37.5	0.083	5.2	15	112.5	1.234	2.1
6	45.0	0.131	4.4	16	120.0	1.446	2.0
7	52.5	0.192	3.8	17	127.5	1.678	1.9
8	60.0	0.266	3.4	18	135.0	1.931	1.8
9	67.5	0.355	3.1	19	142.5	2.205	1.8
10	75.0	0.459	2.8	20	150.0	2.500	1.8

Used in the Worked Example (overleaf)

***for completeness this should include an assessment of the secondary device uncertainty and any method or transmission errors**

A1.11 Average flow figures derived during the day are cross-referenced with Table 1 Appendix 1 and the uncertainty is determined for that period. Table 2 Appendix 1 shows daily readings that might be expected and how the total daily volume and its uncertainty are calculated.

A1.12 A time stamp (Column 1) and average flow (Column 2) are generated by the flowmeter or telemetry system, if present. Columns 3-5 are computed from them.

- Column 3 – ‘15 minute volume’ = $(15 \times 60 \times q_n)/1000$
- Column 4 – ‘Total Volume’ is the cumulative sum of items in Column 3
- Column 5 – ‘Contribution to the Uncertainties in TDV’ is determined using Column 2 and cross-referencing with Table 1
- ‘Total Daily Volume’ is the final line item in Column 4 (or determined by summing of Column 3)
- ‘Total Uncertainty (in the Total Daily Volume)’ is determined by adding Column 5.

Table 2 Appendix 1: Daily Flow Readings and Calculations

Column 1	Column 2	Column 3	Column 4	Column 5
Time	Average Flow (l/s)	15min Volume (m3)	Total Volume (m3)	Contributions to the Uncertainty in TDV (±%)
	q_n			
12:00 AM	0.023	0.021	0.021	0.002
12:15 AM	0.300	0.27	0.291	0.012
12:30 AM	0.300	0.27	0.561	0.012
12:45 AM	0.300	0.27	0.831	0.012
13:00 AM	0.300	0.27	1.101	0.012
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮
11:30 PM	1.100	0.99	68.65	0.030
11:45 PM	0.400	0.36	69.64	0.015
		Total	Q	U_Q
			70	2.05

from Table 1

$\frac{0.021 \times 8.6}{70}$

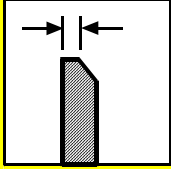
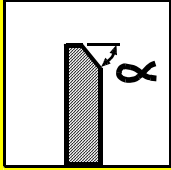
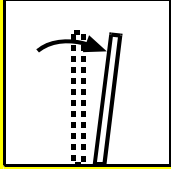
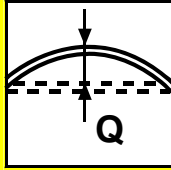
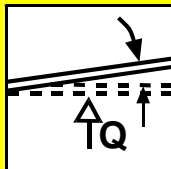
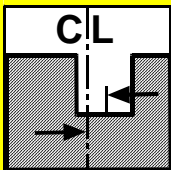
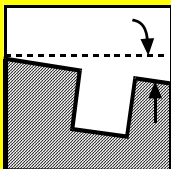
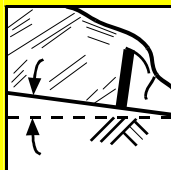
Summation of 'Column 5'

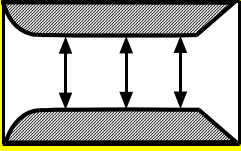
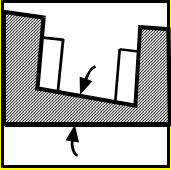
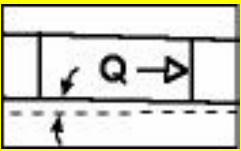
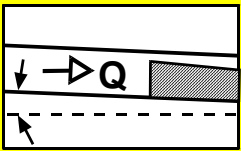
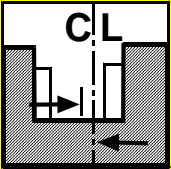
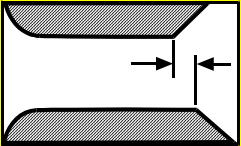
A1.13 In this example total daily volume is calculated as 70m³ and its uncertainty ±2.05%.

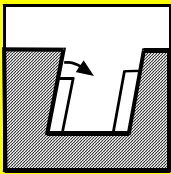
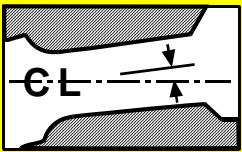
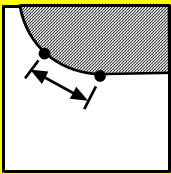
Appendix 2

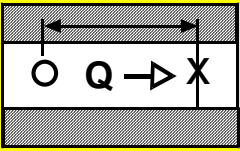
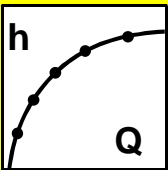
Open channel flow-measurement system concessions

- A2.1 The concessions allowed under MCERTS will principally apply to existing hydraulic gauging structures for determining flow. It is expected that new hydraulic structures will be constructed to the best tolerances that current engineering practices allow and that these devices will remain sufficiently stable to maintain their dimensions for a minimum of five years.
- A2.2 The concessions documented here present “permissible” deviations from international standards (and recognise that the limits and tolerances prescribed are largely unachievable in the field). These concessions are based on the collective wisdom of expert knowledge currently available. They have no formal basis, nor are their effects on flowmeter uncertainty fully understood. As such, the concessions may be adapted in the future to reflect any improved knowledge.
- A2.3 Thin-plate weirs and long-throated critical depth flumes are covered in these concessions, as they are the most common types of open channel primary devices deployed for discharge measurement purposes.
- A2.4 The concessions must not be regarded as a prescriptive “tick sheet”. There may be situations where more than one characteristic is present in a hydraulic structure. It is up to the MCERTS Inspector to exercise professional judgement in considering whether the combined effect of these characteristics is likely to have an adverse effect on flow measurement. There may be occasions when the concessions are exceeded but it can be demonstrated that the installation can still achieve a target uncertainty of better than $\pm 8\%$ at a confidence level of 95%.
- A2.5 All concession items must be logged and recorded, and some provision may be needed in the uncertainty budget (see paragraph 3.4 – Conformance assessment).
- A2.6 Ratios and limits defined in Standards will be followed where practicable; the MCERTS Inspector must exercise professional judgement to consider whether going beyond these limits has an adverse effect on flowmeter performance.
- A2.7 In the case of weirs, it is permissible to install and use drawdown penstocks to facilitate weir chamber cleaning provided they are not detrimental to weir performance when not operated.
- A2.8 Baffles are considered an acceptable solution to stabilise poor flow conditions, but must be fitted in such a way that they do not adversely affect the flow profile and conditions throughout the primary device’s operational range. Perforated plate flow straighteners will not generally be suitable for effluent flows due to their fouling potential. In all cases measures must be taken to ensure that any risk of pollution is mitigated.

PRIMARY DEVICE				
1.1 Thin-plate Weirs – ISO 1438				
Parameter	Diagram	ISO 1438 Standards and Statements	Concession allowable under MCERTS	Clarification
Weir plate edge thickness		1-2mm		Also, there must be no evidence of weir edge erosion
Weir chamfer angle		As per standard		There must be free discharge throughout the range with full ventilation
Verticality of weir plate (degree of uprightness)		Must be vertical	No more than $\pm 5^\circ$ degrees from perpendicular	
Weir plate deflection (amount of bow)		Must be straight	No more than $\pm 2\%$ of maximum weir notch opening or full width for a fully contracted weir plate	
Deviation of weir plate normal to the flow (amount of skew)		Must be square	No more than $\pm 2\%$ of weir width (B)	
Centrality of weir plate (amount of off-centre)		Must be central	Non-central acceptable provided effects of sidewalls are minimal	The width of a weir plate fitted in a circular structure is taken as the chord length
Deviation of the weir plate in the horizontal plane (sideways level)		Must be true and level	No more than $\pm 2\%$ of weir width (B)	
Approach channel level (in the direction of flow)		Must be level	No more than 2° slope from horizontal	If p is large in proportion to gauged head, then channel approach is deemed less critical. Account may need to be made for accurate referencing

1.2 Long-throated, critical depth flumes – BS ISO 4359				
Parameter	Diagram	BS ISO 4359 Standards and Statements	Concession allowable under MCERTS	Clarification
Throat width variation (includes parallax error and non-uniform cross section)		No more than $\pm 0.2\%$ with an absolute maximum of 10mm Minimum $b = 100\text{mm}$	No more than $\pm 1.5\%$ up to and including throat width of 300mm No more than $\pm 5\text{mm}$ for throat widths greater than 300mm A minimum throat width of 50mm is acceptable provided that site conditions are appropriate. An additional 1% uncertainty will be added for structures where $b < 100\text{mm}$.	Applies to critical area being measured where at least 12 transverse measurements are made (most importantly in the wetted area of the throat)
Throat transverse level variation		Average of $\pm 0.1\%$ slope from horizontal	No more than $\pm 1\%$	Over the measured length
Throat longitudinal level variation		Average slope of $\pm 0.1\%$ slope from horizontal	No more than $\pm 1\%$	
Approach level variation		$\pm 0.1\%$ of L slope from horizontal	No more than $\pm 1\%$ (for a distance $10 \times h_{\text{max}}$ upstream)	
Longitudinal level variation		$\pm 0.1\%$ of L slope from horizontal	No more than $\pm 1\%$	
Channel width variation			No more than $\pm 5\%$	
Centrality of flume (amount off-centre)		Must be central	No more than $\pm 5\%$ of approach channel width	
Staggered flume cheeks		$\pm 0.1\%$ of L	No more than $\pm 1\%$ of L	Cheeks can be staggered on both the upstream and/or downstream side

Vertical skew		Deviation from plane of other vertical or inclined surfaces $\pm 1\%$		
Horizontal skew		Deviation from plane of other vertical or inclined surfaces $\pm 1\%$		
Curvature of entrance transition		Arc governed by $R \geq 2(B-b)$ with an allowed deviation of $\pm 0.1\%$ of L	Deviation up to $\pm 5\%$	
Roughness value (Ks)		As per the standard		This can be subjective: suggest for all GRP, plastic and stainless steel devices use a Ks value of 0.6mm For all concrete devices use a Ks value of 1.5mm

SECONDARY DEVICE				
Parameter	Diagram	Requirements in International Standards	Concession allowable under MCERTS	Clarification
Position of sensor		3-4 h_{max} for flumes 2-4 h_{max} for weirs ¹	Relaxation at the discretion of the MCERTS inspector	The point of measurement can be taken from the radial distance from the weir notch provided disturbances and other influences are avoided.
Method of determining flow		Use head to flow equations in standard	Can use Look-up-Tables provided relationship is originally determined using appropriate Standard	Errors using Look-up-Tables should be included in the uncertainty assessment

1 Under the now superseded BS3680 Part 4A the head measurement was required to be 4-5 h_{max} upstream of the weir. Existing sites compliant with the previous standard will maintain their certification but with a recommendation that when the installation is replaced, the measurement point be moved if it is practical to do so.

Appendix 3

Electromagnetic flowmeters for liquid flow in pipes

A3.1 Electromagnetic flowmeters consist of two parts:

- the “sensor” detecting the flow of water, generally provided as a pipe section,
- the “converter” which provides calibrated measurement signals and a readout.

A3.2 If the original factory calibration certificate is available, a copy shall be included in the MCERTS Inspection Report.

A3.3 An on-site inspection by the MCERTS Inspector shall confirm that the flowmeter has been selected and sized correctly, that it is installed correctly and that the effect of any external influences has been assessed. The location of the meter as specified in Section 3.2.2 and its performance will also be assessed.

Meter performance

A3.4 Meter performance shall be confirmed either by inspection with appropriate verification or by secondary testing.

A3.5 Provision shall be made in the sensor installation for either verification or for secondary testing to be carried out. This may take the form of:

- provision of a suitable length of pipe adjacent to the meter to allow the temporary attachment of a clamp-on ultrasonic meter
- access to the pipe end for basic volumetric tests (small flows), or insertion of a velocity/area meter or other temporary device
- provision within the process of a suitable drop or fill tank which can be used from the flow assessment when required.

A3.6 New or replacement electromagnetic flowmeter installations shall be provided with a means of access to allow inspections of the sensor to take place, including general condition, cable connections, earthing and bonding, confirmation of meter type, size, serial number and calibration factors. The design shall enable removal of the sensor if required.

A3.7 New installations shall have sufficient exposed pipe available to install a clamp on flowmeter for verification purposes. The greater of 450 mm or 1.5 pipe diameters is recommended as a minimum.

Meter performance confirmed by inspection

A3.8 The MCERTS Inspector shall inspect the flow measurement system to ensure that:

- the flowmeter has been selected and sized correctly for the application
- in situations where there is more than one flowmeter on site, the converter is connected to the correct sensor
- the liquid is not transporting entrained air
- there is a match between the sensor and the converter
- the converter is properly configured for the application, for example output scaling, meter bore and correct calibration factors read from the sensor head

- the flow readings are stable
- the sensor is running full and is not subject to fouling and/or surface deposition.
- there are no external influences, for example another electromagnetic flowmeter installed alongside the unit being assessed
- the earthing and bonding of the measurement system is appropriate to the type of meter and the type of pipe work installed.

A3.9 The meter uncertainties due to flow disturbances and other effects should be included in the overall site uncertainty calculation (see Table 1 Appendix 3 - sourced from authoritative works, for example WRc report CP259 and NEL documents).

A3.10 Verification shall be carried out at appropriate flow rates to confirm that the meter is performing satisfactorily and that there are no gross errors. The MCERTS Inspector shall record how verification was carried out. The verification shall demonstrate that the meter is operating under full pipe conditions and that the pipe diameter is not compromised by, for example, contamination leading to partial blockage. Significant errors could also be caused, for example, by the meter not being an appropriate size for the flow rate or being a different size to “as installed” information. The agreement between the method of verification and the meter under test shall be within $\pm 8\%$.

A3.11 If the system fails any of the criteria detailed in A3.8, then an MCERTS Site Conformity Inspection Certificate cannot be issued unless the meter performance can be confirmed by secondary testing (see A3.13 – 3.19). NB: Section 2.5 (page 3) of this standard outlines the procedures that need to take place if a dispensation is required.

Table of uncertainties

A3.12 The MCERTS Inspector shall exercise his professional judgement in assessing the total uncertainty. Table 1 Appendix 3 Table of uncertainties (effects due to flow disturbances) and Table 2 Appendix 3 Table of uncertainties (other effects) give guidance and sets out the range of uncertainties for each component part. Each component of uncertainty shall be added in quadrature to determine the overall uncertainty for a particular installation.

Table 1 Appendix 3 Table of uncertainties (effects due to flow disturbances)

Component	Uncertainty range	Guidance notes
Single or double bend	1% - 2%	0-5 diameters upstream or 0-2 diameters downstream from the sensor; orientation of the meter to the bends may affect the uncertainty.
Valve	2% - 18%	0-5 diameters upstream or 0-2 diameters downstream from the sensor. The most significant effect is with a gate valve 50% open.
Conical contraction	0% - 1%	0-5 diameters upstream from the sensor.
Conical expansion	0% - 3.5%	0-5 diameters upstream from the sensor.
Incoming branch flow	0% - 1%	0-5 diameters upstream from the sensor.

Pumps	2% - 18%	0-20 diameters upstream from the sensor. Sensors should not be installed on the suction side of pumps.
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Note: There is no direct correlation between the diameters specified in the guidance notes and the specified uncertainty range

Table 2 Appendix 3 Table of uncertainties (other effects)

Component	Uncertainty range	Guidance notes
Basic meter uncertainty	0% - 1%	A fixed allowance for the basic uncertainty in operation of the meter. A 1% allowance shall be made unless the factory calibration certificate shows otherwise.
Electronic verification uncertainty	1% - 3%	The electronic verification test will indicate several uncertainties for the meter, indicative of changes in the equipment since it was factory calibrated. These include the magnetism test (1% or 2%), mA output test and in some units a frequency test. These shall all be added in quadrature independently. If no electronic verification test is available, then 3% shall be allowed for this item.
Reverse flow uncertainty	Calculated	Calculated as: (reverse flow total ÷ forward flow total) x100. Reverse and forward flow totals to be read from the meter.
Fouling (surface deposition) on the inside of the meter.	Assessed: method of assessment must be detailed.	Calculated by the MCERTS Inspector from the reduction in effective diameter of the meter. Refer to guidance notes for an example.
Air entrapment	Assessed: method of assessment must be detailed.	Entrapped air will displace water passing through the sensor causing over-reading of the flow.

Meter performance confirmed by secondary testing

- A3.13 Under this method an alternative (temporary) means of flow measurement or a drop-test can be used to assess the flowmeter performance. This method is suitable for buried meters or other installations where an inspection cannot be carried out.
- A3.14 Testing with an alternative means of flow measurement may be carried out by comparing the electromagnetic flowmeter with, for example, an insertion probe or clamp-on ultrasonic flowmeter. The measurement uncertainty of these reference methods may be considerably more than the manufacturer's specification for an electromagnetic flowmeter. The MCERTS Inspector should be satisfied that the averaged results from the temporary means of flow measurement and the meter under test correlate adequately. The MCERTS Inspector will use the results in the overall site uncertainty calculation.

- A3.15 For the alternative meter method, a volumetric test combined with instantaneous readings shall be used. The volumetric check shall monitor the flow for a minimum of 10 minutes or 10 cubic metres, whichever is appropriate. The instantaneous readings shall be compared at different rates, typically at high, low and medium flows. At least 10 instantaneous readings shall be taken and the average used for the comparisons. Where it is not possible to take high, medium and low instantaneous flows it may be necessary to base the verification on a single test run. In such cases the number of readings taken shall still be a minimum of 10 but the volumetric test shall be extended to 20 minutes or 20 cubic metres whichever is appropriate.
- A3.16 Drop tests or fill tests may be carried out using any suitable tank or chamber. The actual volume is at the discretion of the MCERTS Inspector, but must be sufficient to allow valid comparisons to be made. The test shall run for a suitable period, at least long enough to allow flow conditions inside the pipe to stabilise. It is likely that the fill or empty period will be greater than one minute. Wherever possible the chamber or tank shall be vertically sided with a small cross section relative to its depth allowing accurate depth measurement and minimising volume errors. Care shall be taken to avoid errors due to empty or part empty pipes. If possible, the test should be repeated at high, medium and low flow rates. The volume recorded by the meter under test shall be compared to the volume discharged or displaced. The test shall be repeated at least three times, more if required.
- A3.17 Other “off line” techniques may also be possible if there is no ready access to the flow meter, for example:
- comparing flows at different flow meters within the site
 - installing a temporary flow meter at an appropriate location in the process.
- A3.18 The MCERTS Inspection report shall include a description of the equipment and the method/s used. Recorded data shall be included with the report to substantiate the results.
- A3.19 In circumstances when verification or secondary testing cannot be carried out then a dispensation should be sought as detailed in section 2.5. Evidence will need to be provided to demonstrate that the meter is installed correctly and that significant fouling/deposition etc is not taking place.

Keeping the meter full

- A3.20 The installation and design shall ensure that the pipe and sensor are running full of liquid at all times. Poor installation conditions may result in a partially filled pipe and sensor under certain conditions. Air entrapment will often result in rapidly fluctuating readings on the flow display.
- A3.21 Ideally the sensor should be orientated such that flow is always in an upwards direction. Any air contained within the water in the sensor will then be carried upwards through the sensor by the flow.

Fouling and surface deposition

- A3.22 The location of the sensor shall be such that sediment cannot settle in times of low flow, for example in a vertical leg of pipe work (the bottom of an invert should be avoided). A cleaning access should be provided. If the flowmeter is installed near

the inlet or discharge point of the pipe, then jetting / brushing can be done without separate access.

- A3.23 It is important to ensure that velocities through the meter are high enough to keep solids in suspension. Higher velocities will be required for untreated sewage than for final effluent. High velocities shall not be regarded as an alternative to regular cleaning.
- A3.24 The orientation of the sensor shall prevent the electrodes from becoming covered should silting occur on the bottom surface of the sensor pipe.
- A3.25 Table 3 Appendix 3 illustrates the errors in measurement for a 150mm electromagnetic flowmeter which result from a reduction of the meter cross-sectional area by surface deposition and so demonstrates the need for a rigorous cleaning regime.

Table 3 Appendix 3 Errors due to deposition

Surface Deposition (mm)	Resulting Error % in Effluent Discharge Flow
1	+3
2	+5
3	+8
4	+10
5	+13

Cabling, earthing and bonding

- A3.26 Electromagnetic flowmeters make use of magnetic and electric fields. Therefore, special potential equalisation procedures need to be followed for conductive pipes. Procedures vary depending on manufacturer, pipe material etc.

Flow disturbances due to other equipment

- A3.27 Disturbances to the flow due to bends, valves, reducers or poor alignment will have a direct effect on the performance of the meter. Ideally, the sensor should be installed in a straight length of pipe of the same nominal diameter, with at least five straight pipe diameters upstream and two downstream.
- A3.28 Valves can have a significant affect on the performance of the flowmeter, particularly when partially closed. Experimental evidence indicates that, for example, a partially closed gate valve located directly upstream of the sensor can produce an error in flow measurement of up to 18%. Within 5 diameters upstream or 2 diameters downstream of the sensor, valves shall be assessed using Table 1 Appendix 3. Valves in this region which are intended to be permanently open shall be locked in this state.
- A3.29 Pumps can also have a very significant affect on the performance of the flowmeter. Ideally, pumps should not be installed within twenty pipe diameters upstream of the

sensor. However, some pump types may permit installation within ten diameters. Sensors should not be installed on the suction side of a pump.

- A3.30 If any of the above cannot be achieved due to physical constraints on site, then uncertainty allowances will be made for the flow disturbance sources. The MCERTS Inspector will use Table 1 Appendix 3 to calculate these uncertainties.

Other sources of uncertainty

- A3.31 The MCERTS Inspector shall ensure that by-pass valves are secure (preferably locked off) to prevent un-planned use.
- A3.32 Reverse flows due to leaky or badly maintained non-return valves, flap-valves or by-pass valves will have a significant effect on flow measurement. Depending on the set-up, any backflow due, for example, to a leaking non-return valve may contribute towards a double-counting error.
- A3.33 Where possible, the MCERTS Inspector should establish that the flowmeter reads zero when no flow is passing through the flowmeter.
- A3.34 The flowmeter should be installed and operated in such a way that it is not affected by electromagnetic interference. Sources of such interference can include other electromagnetic flowmeters installed next to the unit under test (information from manufacturers indicates that there should be a space of at least 2 diameters between units), or mains cables run close by and parallel to the sensor cables of the unit under test. Other sources of interference may also exist.

Electronic verification

- A3.35 Electromagnetic flowmeters are individually calibrated at the factory. Some manufacturers maintain accredited calibration facilities to maintain traceability of calibration for all flowmeters produced. During factory calibration parameters are stored in a non-volatile memory within the flowmeter/converter. Therefore each flowmeter has its own "fingerprint".
- A3.36 Electronic in-situ verification tools perform a series of tests to evaluate the status of the complete flowmeter. These tests include checks on the converter, sensor, signal outputs, system insulation, cables and magnetic circuitry. A number of parameters are recorded and compared with the stored "fingerprint" values that were obtained when the flowmeter was calibrated by the manufacturer.
- A3.37 Electronic in-situ verification is considered to be a very useful tool for assessing the condition of installed electromagnetic flowmeters. However, electronic verification does not measure flow. It only indicates whether the meter characteristics, including fouling, are likely to have changed since the last time the meter was subject to verification. Assessing a electromagnetic flowmeter installation for MCERTS compliance by electronic verification alone is not acceptable.
- A3.38 The results of electronic verification are taken into account in Table 2 Appendix 3 and can be used as one element of an annual review procedure. Where a flowmeter is buried, inspection of as-installed drawings and/or photographs may enable the operator to demonstrate that the flowmeter has been installed correctly and that the measurement still represents the discharge flow. Inspection of as-installed drawings and/or photographs is not necessary when the flowmeter can be verified by an alternative method, for example, a drop test.

